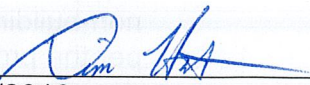


LATERAL FORCE DESIGN CRITERIA

Approved: 

Date: 3/5/2019

Rev.:18 By TMH

The following lateral force design criteria shall be used for the design of all conventional and laboratory facilities at the Lawrence Berkeley National Laboratory, Berkeley, California.

All structures and non-structural elements of buildings shall be designed and constructed to withstand all lateral forces in accordance with American Society of Civil Engineers (ASCE) Standard 7-10 as modified by the 2016 edition of the California Building Code (CBC) adopted by the Building Standards Commission and the following:

1. The seismic base shear for building and non building structures anywhere on the LBNL site may be calculated for latitude $37^{\circ} 52' 33''$ and longitude $122^{\circ} 14' 51''$. The height of a structure (h_n) is to be measured from bottom of the lowest level which is exposed to the weather on at least one side to the top of the roof. Seismic analyses will utilize the static lateral force procedures of the CBC unless a dynamic analysis is necessary. When a dynamic analysis is required, the analysis procedure shall be either a modal response spectrum analysis or a non-linear time history analysis. The modal response spectrum shall be a site-specific spectrum developed by a California registered Geotechnical Engineer and scaled to the target intensities specified in ASCE 7-10. If a time history analysis is performed, the ground motions selected shall meet the requirements specified in ASCE 7-10 Chapter 16. The ground motion time histories specified in *Ground Motion Time Histories for the UC Berkeley Campus* (LBL-62614) may be used if deemed appropriate for the project site by the Geotechnical Engineer of Record.
2. The drift and deformation of building structures anywhere on the LBNL Berkeley campus shall comply with Section 12.12 of ASCE 7 with the following exception: in Table 12.12-1, the allowable drift of "Structures, other than masonry shear wall..." (the first row of the Table) for Category I or II shall not exceed $0.020h_{sx}$ and footnote "c" of the Table is deleted. The drift and deformation of non building structures shall comply with Section 15.4 of ASCE 7. The seismic relative displacements of nonstructural components shall be considered as appropriate per Section 13.3.2 of ASCE 7.
3. The bracing and anchorage of all building related or conventional non-structural elements, such as mechanical equipment, plumbing and electrical equipment, machines, partitions, ductwork, etc., anywhere on

the LBNL Berkeley campus shall be comply with Chapter 13 of ASCE 7. Equipment that is not attached to a building structure or supported by a non-building structure covered in Chapter 15 of ASCE 7 shall be designed per the provisions of Chapter 13. Either Chapter 13 or 15 can be used to design non-building structures that are inside buildings and are only attached to the building's foundation.

4. The anchorage of the following non-building elements are to be designed by a California registered Civil or Structural Engineer and shown on the Construction Documents:
 - a. Any structure that personnel can enter, such as trailers, radiation hutches, shielding structures, or environmental test chambers;
 - b. All equipment and furnishings that are more than 4 feet tall, regardless of weight;
 - c. All equipment and furnishings mounted to a floor or roof and weigh more than 400 pounds, including furniture, storage cabinets, laboratory equipment, mechanical components, and electrical components;
 - d. All equipment and furnishings mounted to a wall or suspended from above and weigh more than 20 pounds;
 - e. All equipment and furnishings mounted on a table top and weigh more than 100 pounds. The table would also need to be anchored;
 - f. All equipment and furnishings that could block doors or exit passages if they fall, regardless of height or weight;
 - g. 160 liter dewars and compressed gas cylinders;
 - h. Mechanical and electrical distribution systems except for those listed as exceptions in ASCE 7-10 Section 13.6. These exceptions do not apply to fire protection sprinkler piping or to systems that contain hazardous materials;
 - i. Any equipment, distribution system, storage cabinet, or container that contains hazardous materials;
 - j. Exemptions: It is recommended that the following items be anchored for seismic loads. However, these items are exempt from the requirement for an anchorage design by a Registered Engineer:
 - i. Temporary equipment (6 months or less);
 - ii. Equipment that is designed to be movable as part of its operation or use;
 - iii. Mechanical and electrical components meeting all of the requirements of ASCE 7-10 Section 13.1.4 Item 6;
 - iv. Furniture that does not fall under Items b, c, d, e, or f.

When dynamic analysis is required in accordance with paragraph 1 above, the use of roof and/or floor spectra may also be required for the design of the anchorage of non-structural elements.

The ASCE 7 importance factor (I_p) shall be 1.5 for the design of seismic bracing for the following units and systems:

1. Fume hoods;
2. Laminar flow hoods;
3. Bio-safety cabinets;

4. Chemical storage cabinets;
5. Ductwork, exhaust equipment, filters and blowers associated with these elements.
6. Ductwork, exhaust equipment, filters and blowers for clean rooms containing biological or chemical hazards;
7. Any nonstructural component listed in ASCE 7-10 Section 13.1.3.

The exceptions listed in ASCE 7-10 Section 13.6 are not applicable to components with an importance factor of 1.5.

Fire protection piping supports and bracing shall be designed to NFPA 13 as adopted by the State of California. Anchors for fire protection systems shall comply with ASCE 7-10 Section 13.6.8.2.

Anchors to concrete shall be designed to Chapter 19 of the California Building Code. Allowable Stress Design is not permitted for the design of anchors resisting seismic forces or for anchors installed in hardened concrete (i.e. post-installed anchors). All anchors shall be prequalified for seismic applications per ASCE 7-10 Section 13.4.2.3.

The installation of post-installed anchors into concrete or masonry shall be special inspected per CBC Table 1705.3. Adhesive anchors shall be proof load tested in accordance with ACI 355.4. Expansion anchors may also be tested at the discretion of the Engineer responsible for the anchor design. The test loads, frequency, and acceptance criteria shall be specified by the Designers of Record and shown on the Construction Documents.

5. The seismic design criteria for programmatic equipment, shielding and hazardous or toxic material handling systems including piping, ductwork, equipment, etc. shall be in accordance with the LBNL Requirements and Policies Manual (RPM) section on Seismic Safety.
6. The allowable deflection of buildings, structures and their elements or components when subjected to the required wind pressures shall not exceed $L/240$, where "L" is the appropriate length or height of the element under consideration.
7. Building and non building structures anywhere on the LBNL site shall be designed for the wind exposure determined from the criteria specified in CBC Section 1609.4.3. The value for K_{zt} shall be calculated per ASCE 7-10 Section 26.8 and not assumed to be 1.0. The alternate all-heights method specified in CBC Section 1609.6 may be used in lieu of the provisions in ASCE 7-10 if the building meets the conditions listed in CBC Section 1609.6.1.
8. All foundations, earth retaining structures and other earthworks shall be designed in accordance with the recommendations of a California registered Geotechnical Engineer. The design of foundation walls

retaining six feet or more of earth shall include earth pressures from seismic forces.